SUPER-POWER KLYSTRON TUBE-TEST FACILITY

G-108

Quarterly Report No. 4

for the period

July 1, 1961 through September 30, 1961

Prepared for

Varian Associates
611 Hansen Way
Palo Alto, California

U. S. Army Signal Research and Development Laboratory
Fort Monmouth, New Jersey

By

RADIATION at STANFORD
3180 Hanover Street
Palo Alto, California

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Written by: Roby L. Blessing
Project Engineer

Approved by: Harry G. Heard
Vice President and Chief Engineer
RADIATION at STANFORD

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INTRODUCTION

At the beginning of this quarter most of the remaining short-lead items were ordered. The final detailed design of the auxiliary circuits continued. The design of the interim modulator was completed. The mechanical design of major subassemblies and most of the panel drawings and panel wiring diagrams were complete. Essentially all of the schematic drawings were completed and released. The procurement of all items proceeded on schedule.

The design efforts during this quarter resulted in specification of remaining components of the system except the klystron tank, high-voltage transmission lines, and final modulator. While significant efforts were made in these areas during the quarter, much work remains. Designs for these components will be based upon the high voltage tests. Many of the high voltage tests were performed during this quarter, including the evaluation of two Machlett switch tubes. A breadboard modulator was constructed and used to evaluate the switch tubes. Enough test data was obtained such that the circuit design of the final modulator can be started.

The building layout at Varian has been formalized and submitted to Varian for approval. Based on their approval, the required conduits and gutters can be installed. The location and orientation of the klystron was frozen. Consideration was given to the access and location of the r-f load and r-f monitoring equipment.

Progress continued in the fabrication of the interim modulator pulse transformers, and at the end of the quarter the pulse transformer tank was delivered to our facility. One pulse transformer core assembly was not delivered. Delivery was rescheduled for early in

the quarter. The fabrication of the interim modulator pulse transformers should be completed during the first period of the next quarter.

Efforts will continue in the next quarter to finalize these items wherein significant amount of test effort will be required. As soon as the High-Voltage Building is completed at Varian, installation of equipments will start.

I. BEAM SUPPLY

A. Line Disconnect Switch

The 4160 volt disconnect switch has been received and placed in storage at Varian. This switch will be used by Varian for their installation outside the High-Voltage Building in the near future. This transfer can take place at any time desired by Varian.

B. Inductrol

The status of the 2270 kva Inductrol remains the same as previously reported; that is, it is stored at the Varian site and is available for installation in the High-Voltage Building at the conclusion of the construction program.

C. Plate Transformer

The construction phase for this transformer is nearing completion by Moloney Electric Company. Preliminary acceptance tests on this transformer should take place at Moloney Electric, St. Louis, during the first period of the next quarter. Copies of the test specifications for this transformer will be delivered to Radiation at Stanford in the immediate future for review before the test program takes place. A Radiation at Stanford representative will be present for the evaluation tests and preliminary acceptance of the transformer at Moloney. The shipping schedule has been delayed so as to coordinate with the completion of the new Varian building. This should minimize the cost of installing this 85-ton transformer on the site.

D. D-C Meter Multiplier Resistor

Construction of this resistor was completed during the quarter. This resistor will be utilized for high voltage tests at Radiation at Stanford as required during switch tube and modulator evaluations.

This resistor will be installed at the Varian site upon completion of the High-Voltage Building.

E. Klystron Cathode Resistor

It has been necessary to utilize some of the materials originally scheduled for this resistor to construct the equipment for the switch tube tests. These materials include the glass for containing the resistor, as well as the corona spinnings for the ends of this assembly. Additional spinnings are scheduled for arrival momentarily. The glass is scheduled for delivery early in the next period. The resistor construction will be completed upon receipt of materials. The completed resistor will be d-c and impulse tested prior to installation. Tests have been designed to simulate the normal as well as transient operating conditions that are expected during crowbar operation. Tests of this resistor depend upon receipt of capacitors for the 750 kv impulse generator.

F. Silicon Diode Rectifiers

Shipment of the IRC silicon diode modules was completed during the quarter. The plastic capacitors that were returned to the vendor for rework (due to oil leaks) have also been returned to Radiation at Stanford. The repaired capacitors have again been assembled in the high-voltage rectifier columns. All of the columns are awaiting installation at the Varian site.

II. FINAL MODULATOR (Ground Deck, Buffer Deck and Floating Deck)

A preliminary design of the r-f link to coupled trigger pulses from ground level to the buffer and floating deck levels has been completed. The remaining ground level circuitry will consist basically of a pulse

modulator to be operated into this r-f link at ground level. The preliminary design of the detecting circuitry that is to be located on the floating and buffer decks has been completed. These designs cannot be finalized as yet due to their inneraction with the remainder of the system and the circuitry associated with the floating and buffer decks. Based on the results obtained with Switch Tube No. 2 and the breadboard modulator, and the Switch-Tube-Test-Supply, modulator design criteria were established during this quarter. Upon completion of the remaining tests during the next quarter, the design of the ground circuitry, the buffer and the floating decks will be completed and the components placed on order. The construction phases will take place upon completion of production drawings and the delivery of components.

III. MAGNET SUPPLIES

The magnet supply sections of the control console, which have been completed for several weeks, are now under test. Varian has requested early delivery of the magnet supplies to expedite tests on the klystron magnet assemblies. The supplies will be delivered to Varian and will later be attached to the control console when it is installed at Varian.

IV. KLYSTRON FILAMENT TRANSFORMER

This transformer will be delivered tested by Moloney Electric Company and delivered at the same time as the main plate transformer.

V. MOD-ANODE BIAS SUPPLY AND ASSOCIATED COUPLING RESISTORS

These assemblies were completed some months ago. They have been partially torn down to provide standoff insulators and corona

shields for use in the switch tube tests. The borrowed component parts will be returned to their respective assemblies upon the completion of these evaluations. Should it become apparent that the use of these components for switch tube tests will interfere with the final construction of the klystron tank assembly, additional corona shields and standoff insulators will be procured.

VI. COOLING SYSTEM

The cooling system design has been completed with the exception of the water manifold to supply coolant to the klystron proper. This design cannot be completed until the final drawing of the klystron is supplied by Varian. The integration of the manifold and the interconnecting plumbing for the cooling system is continuing on a scale compatible with the overall system layout. The remaining plumbing details will be finalized during the next quarter. All of the required materials with the exception of the interconnecting pipe have been received during the quarter. The remaining piping will be procured as required to coordinate with the plumbing installation schedule at Varian.

VII. D-C DUMMY LOAD

The Switch-Tube-Test-Supply was used to collect preliminary design data for the d-c dummy load. This load will be used for the initial test of the high-voltage power supply and is not necessary as a permanent component in the system. The 85-kilowatt water-cooled resistor utilized in the system for klystron protection operates at the full beam voltage level, with the coolant water source and return located at ground potential. Consequently, the voltage standoff

problems that have been investigated in the presence of coolant water will also be used for the design of the resistor. The design and construction of the d-c load will continue in the next quarter and will be integrated with the switch tube tests and high voltage standoff evaluations.

VIII. CONTROL CONSOLE

The production phase for the control console has continued during the quarter. Production effort has not been as intense as originally anticipated. Manpower was channelled instead into the switch tube evaluation, interim modulator, and the assembly of the rectifier columns. The control console production labor during this quarter resulted in fabrication of all panels and their installation. A major portion of the subassemblies has been completed. During the next quarter effort will continue on subassembly innerconnection inside this cabinet and the final installation of the remaining panels and subassemblies. The production and test phases on this console will be completed during the next quarter.

IX. COLLECTOR-CAPACITOR BANK

No work was done on either the collector or body capacitor banks during this quarter. The steel framework has been stored.

X. CROWBAR

The Cornell Dubilier replacement capacitors for the crowbar circuitry are overdue. These crowbar capacitors are to replace the existing units which have failed repeatedly under test. Fabrication of the capacitors has not started at Cornell Dubilier as of the date of this report.

XI. CROWBAR LOGIC CIRCUITS

Some design effort was placed on these circuits during this quarter. The design of the output stages of the circuitry has been completed. This circuitry was designed with low source impedances so as to provide both adequate triggering for the thyratrons as well as eliminating a significant number of known problems associated with fast current transients. Consideration has also been given to careful double shielding of the input circuitry from transients. These transients are expected to occur during normal system pulsing operations and to a greater degree following system crowbar action. This circuitry has been designed to provide a visual indication, in terms of an indicator lamp, of the particular system malfunction causing the crowbar action. It is possible that transients generated at the time of a system crowbars to provide transients at the inputs of level sensing circuitry and thereby generating ambiguous indications.

Consideration has also been given to the packaging configuration of the circuitry. Final assembly is scheduled for completion early in the next quarter and will be subjected to a rigorous test schedule before being installed in the control console.

XII. INTERIM MODULATOR POWER SUPPLY

The status of this power supply remains as previously reported.

The pulse transformer tank was received and has been installed in the test area. At the conclusion of the interim modulator tests this power supply will be moved to the Varian site.

XIII. INTERIM MODULATOR PULSE GENERATOR

The production engineering phase for this pulse generator was completed during the quarter. A major portion of the required components were received. The vendor from which the electrically-activated rotary switches were ordered was not able to meet their delivery schedule. This difficulty was due to problems encountered fabricating the rotary switch wafers for the assembly. The required wafers were obtained by our vendor from a second source of supply and delivery of the completed switches was made to our facility late in the quarter. Unfortunately, these switches are intricately arranged both electrically and mechanically with the associated circuitry in this pulse generator. Consequently, the production phase for this unit was delayed. Some production labor was used to fabricate the required enclosures, brackets, supports, etc. The wiring of this assembly will take place during the first period of the next quarter so that significant delays should not occur in the overall interim modulator test program.

XIV. INTERIM MODULATOR SWITCH DRIVE

The major assemblies and components have been installed in this unit. Shop work is required on the plumbing for the flow monitoring, the control equipment, and the interconnecting wiring inside the unit. This unit is scheduled for completion during the first two weeks of the next quarter and will be tested with the interim modulator power supply and the pulse transformers.

XV. INTERIM MODULATOR SWITCH TUBES AND PULSE TRANSFORMERS

The first pulse transformer core was delivered late in the quarter. The fabrication phases for the core coil assemblies have been in process during the last period of this quarter, and this transformer is scheduled for completion during the first two weeks of the next quarter. The second core has not been received. Fabrication difficulties were encountered at Moloney Electric Company. The completed core did not meet the required specifications. It was necessary for the manufacturer to tape the second core to meet these specifications. The latter is scheduled for delivery early in the next quarter and will be immediately tested at our facility to insure compliance with the required specifications.

Construction phases for pulse transformers will be initiated immediately upon receipt of an acceptable core. Construction of associated subassemblies used for the fabrication of the final transformer assemblies has already taken place. Every effort has been made to insure that the fabrication phase can continue in the most expedient manner upon receipt of the final core. Upon completion, these transformers will be installed in the pulse transformer tank and the oil will be processed. The transformer test program can start immediately upon completion of this phase.

XVI. INTERIM MODULATOR CROWBAR, POWER SUPPLY AND TRIGGER

The status of these items remains unchanged. Tests will start when the interim modulator is turned on.

XVII. INTERIM MODULATOR CROWBAR LOGIC CIRCUITRY

This circuitry has been completed with the exception of a rotary switch already mentioned. The circuitry was previously installed in the power supply cabinet and the interconnection completed. The switch will be installed as soon as it is received and will be ready for test with the interim modulator.

XVIII. KLYSTRON TANK

The final design of the klystron tank awaits test data obtained from the switch tube tests and high voltage standoff requirements. Radiation at Stanford has coordinated design efforts with Varian to determine the most desirable orientation of the klystron mod-anode bushing with respect to the output window on the klystron.

High voltage measurements are being made to define the minimum strike, creep, and migration distance so as to minimize tank size. Based upon high voltage data obtained to date, it has been possible to make some of the decisions associated with the klystron tank configuration. It has also been possible to complete the specification of the major portion of the remaining system assemblies as discussed under system layout section. Maximum effort will continue on this layout so as to finalize the configuration as earl, as possible in the next quarter.

XIX. SYSTEM LAYOUT

The layout for the existing building continued during the quarter. The detailed layout for the interim modulator and control console are ready for submission to Varian. The required drawings

showing the equipment locations will be submitted to Varian for approval early in the next quarter. Based on the resulting decisions, the required conduit and gutters can be installed in the existing building to power these equipments.

High voltage test data were used to obtain a preliminary design for the high-voltage transmission line. This oil-filled coaxial transmission line design will be submitted to Varian for their consideration along with the high-voltage transmission lines available from outside sources. As previously reported, problem areas are associated with the reliability of the available transmission lines, and the availability of suitable terminations.

XX. PULSE-COUPLING CAPACITOR

This assembly is now being utilized for high voltage tests on the Machlett switch tube.

XXI. PULSE-VIEWING RESISTOR

The component resistors required to complete the fabrication of this item were received during the quarter. The production effort is nearing completion and this resistor will be available for use early in the next quarter.

XXII. SWITCH TUBE TEST SUPPLY

The 350 kv, 50 ma power supply was completed and tested during this quarter. It is presently being used to test switch tubes and evaluate components.

XXIII. INPUT POWER CONTROL UNIT

Problems associated with the oil circuit breaker have been resolved. A corrected schematic diagram has yet to be received from Westinghouse. In the interim we are proceeding with modifications based upon a marked schematic provided by the Westinghouse field engineer. All components are now available for the fabrication of this unit and the production engineering should be completed early in the next quarter. The production will be completed during the next quarter. The cable for the 5 kv input power connections was received. Installation of this cable in the Varian High-Voltage Building awaits completion of that building.

XXIV. MACHLETT SUBCONTRACT

The switch tube test tank and insulator were assembled and filled with processed oil during this quarter. The Switch-Tube-Test-Supply was used with a breadboard modulator, radiation shielding, and the required interconnecting circuitry and monitoring equipment to evaluate the switch tubes. High voltage tests were performed and drive characteristics were measured on Machlett switch tubes Nos. 1 and 2 during this quarter. Machlett Switch Tube No. 1 was operated with a cold heater to determine the voltage standoff capabilities. After many days of careful conditioning the tube envelope punctured at approximately 325 kv. This puncture occurred at the anode glass-to-metal seal.

The second tube was installed and carefully processed, with the heater cold, up to approximately 400 kv. It became apparent during these tests that the corona shield of the tube was inadequate and would have to be redesigned to stop sporatic discharges. The configuration

and location of the internal and external tube shields do not appear to reduce the gradients at the glass-to-metal seals.

All switch tube tests were performed in the presence of a Machlett representative at Radiation at Stanford. The second tube was operated with the heater-cathode hot and with bias applied to the tube up to voltages of approximately 250 kv. High voltage tests were then stopped so as to obtain pulse data on this tube in case a similar envelope fracture precipitated. The breadboard modulator was used to pulse the switch tube and obtain necessary design and grid drive data. Additional high voltage tests were then performed with the heater-cathode hot. The maximum voltage placed on the tube under these conditions was 325 kv. Operation at voltage levels above 300 kv could only be maintained for a matter of seconds before sporatic gas bursts occurred. Additional processing of this tube has taken place and the tube is continuously pumped at all times. To date the tube has been operated up to voltage levels of approximately 280 kv without significant difficulties. At these voltage levels additional processing continues to be necessary in order to obtain satisfactory operation. None of the high voltage tests occurred during conditions wherein the tube was operated with significant grid or plate dissipation.

A puncture developed in Tube No. 3 at Machlett during the last two weeks of this quarter. Consequently, there are no additional tubes available. Tube No. 4 has not been assembled. Machlett has concluded that there is a problem due to the nonuniformity of thickness of the glass used for these tubes and that this can only be resolved by procuring a glass mold. The authorization for this mold has been supplied to Machlett. The fabrication of the glass bulb will be performed by Corning Glass. Based upon the current schedule obtained from Machlett,

the next meld of this particular glass type will be ready in November. Machlett will submit a firm schedule for completing the fabrication of additional tubes early in the next quarter.

XXV. SWITCH TUBE TEST DRIVER CIRCUITRY

The design, construction, and test of a breadboard drive circuitry was completed during the quarter. The equipment was used to test the switch tube. The output of the drive circuitry was conservatively designed to drive the Machlett switch tube under the worst conditions. Utilizing the data obtained in grid drive tests it has been possible to formulate most of the design criteria required for the final modulator circuit. Minor refinements are now being made in this breadboard driver so as to model the final circuitry. These modifications will result in a simplification of the circuitry, an increase in reliability, and a reduction in physical size. Additional tests will be performed utilizing Switch Tube No. 2 when these modifications have been completed. The breadboard modulator and high voltage test facility will be retained to perform tests on additional Machlett tubes as they are received.

XXVI. CONCLUSIONS

During the quarter Engineering has completed the design of system details associated with integration and installation of the system. The system layout of the klystron tank has continued. The integration of all system assemblies for on site installation has neared completion. The test program has started and has included the evaluation of two Machlett switch tubes under both high voltage and pulsed conditions. Information has been obtained that will expedite the design

of the final modulator as well as the design of the remaining equipment involving high voltage insulation problems. Additional effort has been placed on the design of the oil-filled high-voltage transmission line. This information will be submitted to Varian for approval.

The interim modulator pulse transformers are being fabricated. The pulse transformer tank was delivered. The core for the second transformer has not been received. It is scheduled for delivery early in the next quarter.

Production Engineering effort has been placed on completion of the mechanical details associated with the interim modulator, control console, input power control unit and pulse transformer tank. The klystron tank and system layout are under design. The preliminary design of the high-voltage transmission line has been completed.

Production effort was delayed due to lack of a construction site and component deliveries. The interim modulator, the Switch-Tube-Test-Supply, and the switch tube and high voltage evaluation tests were, however, ahead of schedule. A major portion of the system subassemblies have been completed. There was a continuing effort on the control console. The interim modulator items with the exception of the trigger generator, are available for installation in the interim modulator cabinet. The latter was ordered late in the quarter. The interim modulator switch tube assembly is near completion.

The major purchasing effort during the quarter has been associated with followup and expediting of system components and very little procurement effort has been necessary.

XXVII. PROGRAM FOR THE NEXT INTERVAL

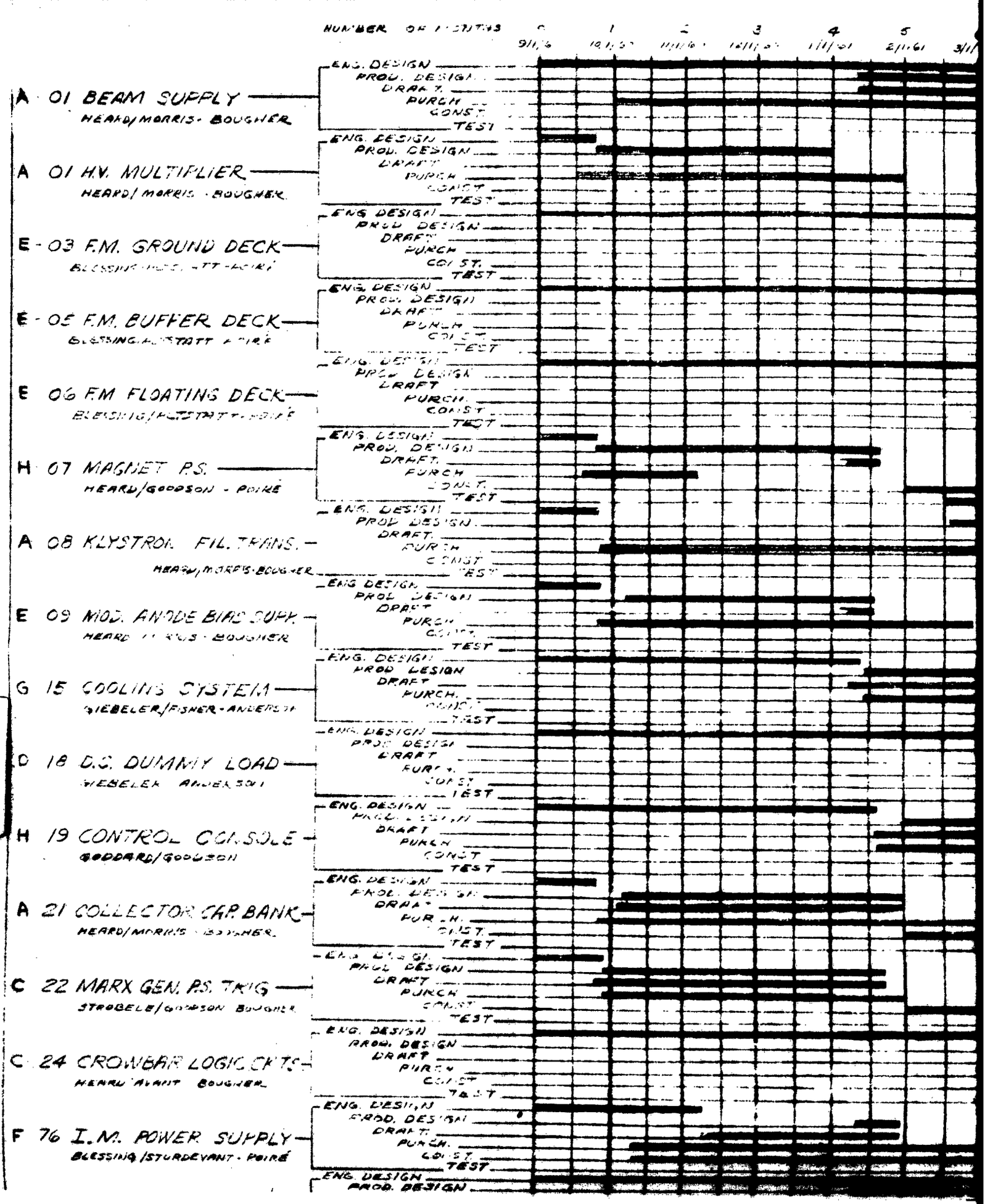
During the next quarter most of the Engineering effort will be concentrated on the test phase of the interim modulator. Switch tube and high voltage evaluation tests will continue and the resulting information will be utilized to complete the klystron tank and high-voltage transmission line design.

Production Engineering effort will continue on the klystron tank, high-voltage transmission lines, input power control unit, system layout and system interconnection.

Production effort will continue on the interim modulator pulse transformer assemblies, the assembly of the interim modulator circuitry into the cabinet, and the completion of the control console. Upon completion of the High-Voltage Building, an intensive production effort will take place to install the high voltage components in that building.

XXVIII. TECHNICAL PERSONNEL ASSOCIATED WITH THIS PROJECT

R. L. Blessing, overall Project Manager; J. Sturdevant, interim modulator Project Manager; support technical personnel include H. G. Heard, A. J. Morris, R. Giebeler, D. Avant, H. Jessup, and J. Altstatt. Engineering facilities were managed by H. G. Heard; Production Engineering and Drafting facilities by W. Bougher, and Production facilities were managed by E. Anderson.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10/1/60
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HEARD/MORRIS - BOUGHER
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HEARD/MORRIS - BOUGHER
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BLESSING/STURDEVANT - POIRÉ
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F 76 I.M. POWER SUPPLY
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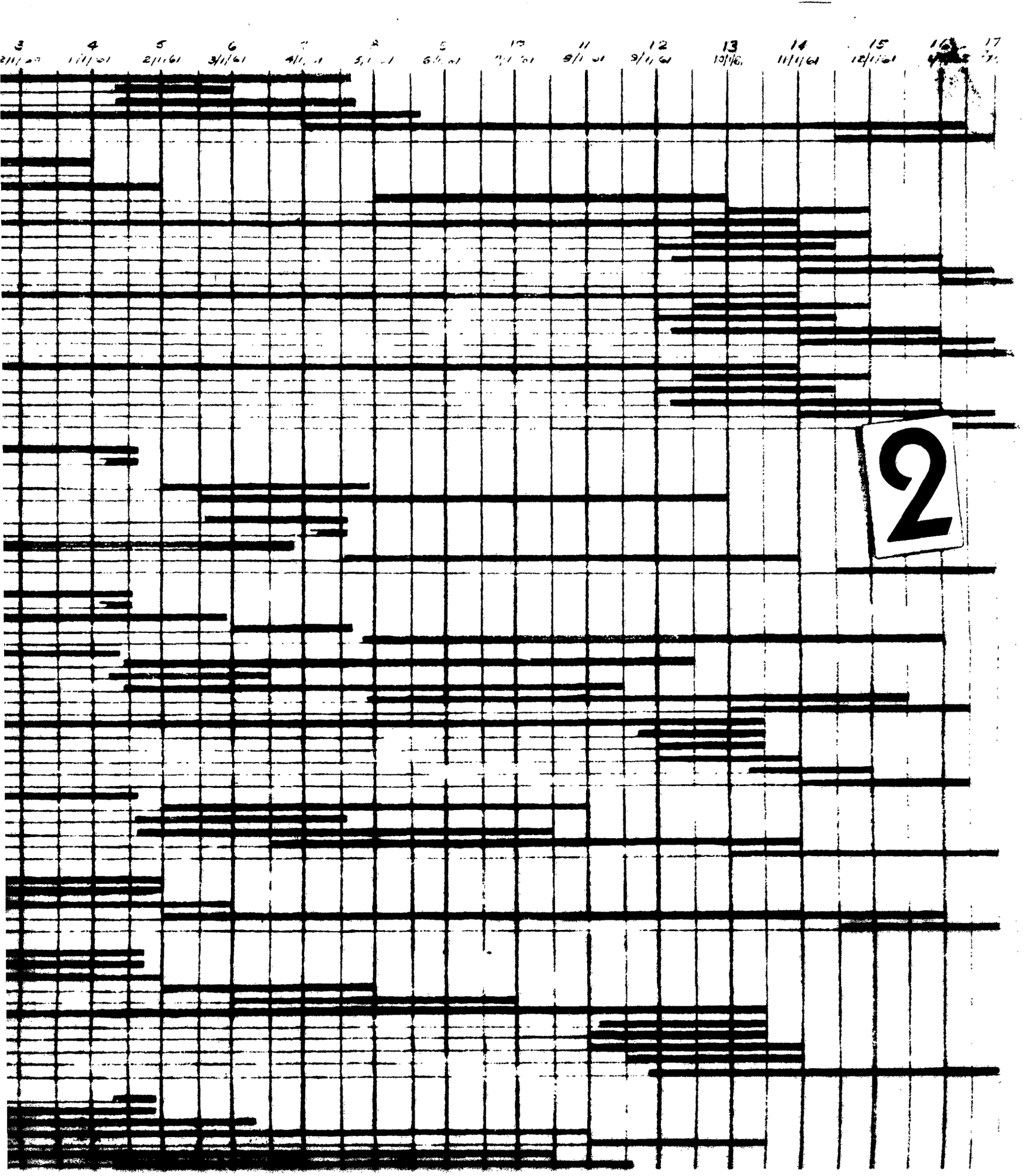
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RADIATION at Stanford / 3180 Hanover Street Palo Alto, California

PROJECTED SCHEDULE FOR POWER SUPPLY (G108) MODULATOR SYSTEM

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